

APPENDIX D. MICROBIOLOGICAL INDICATOR ORGANISMS IN STANDARDS AND GUIDANCE

To protect the recreating public from exposure to microorganisms associated with the presence of sewage in at beaches and in recreational waters, health agencies use microorganisms such as total coliform bacteria, fecal coliform bacteria, enterococci, or *E. coli* as indicators of water quality. Though they are not considered disease-causing agents, their presence above certain numeric levels is suggestive of the presence of other, difficult to detect and quantify pathogenic microorganisms that can cause health effects. The use of the general indicators is an inexpensive, effective way of monitoring the overall well-being of recreational waters.

The use of indicator organisms is public health protective. However, using surrogates as monitoring endpoints makes quantitative risk assessments difficult, and does not enable development of dose/effect relationships, traditional risk assessments (as used in the regulation of chemical contaminants, for example), and predictions of actual risk from disease-causing organisms in recreational waters. The difficulty arises from:

- determining exposure to the disease-causing microbes (the "dose"), which requires quantitation of the specific organism under actual recreating circumstances, which, even if possible analytically, is expensive. For example, monitoring for specific pathogens such as *Giardia* or *Cryptosporidium* is costly and appears not to yield predictable, reliable results.
- determining the risk of illness (the "effect"), which requires epidemiological studies of the recreating public in parallel with water analyses for specific. Epidemiological studies of recreational bathers that have been done generally use indicator organisms, though case-histories of specific disease outbreaks are more specific (see [Appendix E](#)).

D.1 Microbiological Indicator Organisms

D.1.1. Total Coliform Bacteria

The term total coliform bacteria refers to a number of bacteria including *Escherichia*, *Klebsiella*, *Citrobacter* and *Enterobacter*. They are able to grow at 35° C and ferment lactose. These are all gram negative asporogenous rods and have been associated with feces of warm-blooded animals. They are also present in soil.

D.1.2 Fecal Coliform Bacteria

Fecal coliform bacteria are a subgroup of the total coliform group. They are able to grow at 44.5° C and ferment lactose. These bacteria have found use as indicators of fecal contamination, because they are restricted to the intestinal tract of warm-blooded animals. Their use enables separation of bacteria of soil and fecal origin.

Among the fecal coliform group, *E. coli*, an indicator of fresh fecal pollution, has also found some use as an indicator organism (US EPA, 1986).

D.1.3 Streptococcus Bacteria (and Enterococcus Group)

The table below indicates the *Streptococcus* species and subspecies that are used as indicators of fecal contamination.

Indicator organism	Enterococcus group*	Streptococcus group
Group D antigen		
<i>Streptococcus faecalis</i> **	X	X
<i>S. faecalis</i> subsp. <i>liquefaciens</i>	X	X
<i>S. faecalis</i> subsp. <i>zymogenes</i>	X	X
<i>S. faecium</i> **	X	X
<i>S. bovis</i>		X
<i>S. equinus</i>		X
Group Q antigen		
<i>S. avium</i>		X
<p>-----</p> <p>* excludes <i>S. bovis</i>, <i>S. equinus</i>, and Group Q organisms.</p> <p>**also includes some Group Q antigen reactive types that occur in humans, dogs, and pigs.</p>		

The normal habitat of fecal streptococci is the intestines of humans and animals; therefore these microorganisms are indicators of fecal pollution. (*Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, 1985). The enterococcus group is a subgroup that is considered more indicative of pollution associated with human sewage. The streptococcus group, when there is a predominance of *S. bovis* and *S. equinus*, is considered to be related to the excreta of nonhuman, warm-blooded animals, as might be related to meat-processing plants, dairy wastes, and feedlot and farmland runoff. *S. faecalis* subsp. *liquefaciens*, besides being associated with mammalian feces, is also associated with vegetation, insects, and certain soils, and may predominate when counts are low (less than 100 per 100 ml).

D.1.4 Other Indicators

A number of possible indicator organisms other than those presented above have been evaluated for marine waters. As summarized by US EPA (1986), other microorganisms that were evaluated for their correlation with swimming-associated gastroenteritis included *Klebsiella*, *Enterobacter/Citrobacter*, *Clostridium perfringens*, *Pseudomonas aeruginosa*, *Aeromonas hydrophila*, *Vibrio parahaemolyticus*, and Staphylococci. Because of poor correlation, none of these was considered helpful as an indicator organism.

Initial draft: November 1997

REFERENCES

See <http://www.dhs.ca.gov/ps/ddwem/beaches/pdfs/references.pdf>